ORVR COMPATIBLE VACUUM ASSIST FUEL DISPENSERS

This application claims the benefit of U.S. Provisional Patent Application Serial No. 60/461,097, filed April 8, 2003 which is hereby incorporated by reference in its entirety.

BACKGROUND OF THE INVENTION

This invention relates generally to refueling systems for vehicles and, more particularly, to assist-type vapor recovery systems for the refueling of vehicles that are compatible with vehicles having onboard refueling vapor recovery (ORVR).

In fuel dispensing systems, such as those used for delivering gasoline to the fuel tank of a vehicle, environmental protection laws require that vapors emitted from the tank during the fuel dispensing process be recovered. Fuel is customarily delivered through a nozzle via a fuel hose and vapors are recovered from the nozzle via a vapor hose that conveys the vapor to the storage tank from whence the fuel came. In what is referred to as a balanced system, the vapors are forced through the vapor hose by the positive pressure created in the vehicle tank as the fuel enters it. In other systems, referred to as assist-type systems, the vapor is pumped from the vehicle tank into the storage tank by a vapor recovery system connected to the vapor hose. Currently, many fuel dispensing pumps at service stations are equipped with vacuum assisted vapor recovery systems that collect fuel vapor vented from the fuel tank filler pipe during the fueling operation and transfer the vapor to the fuel storage tank.

Onboard, or vehicle carried, fuel vapor recovery and storage systems (commonly referred to as onboard refueling vapor recovery or ORVR) have been developed in which the head space or ullage in the vehicle fuel tank is vented through a charcoal-

filled canister so that the vapor is absorbed by the charcoal. Subsequently, the fuel vapor is withdrawn from the canister into the engine intake manifold for mixture and combustion with the normal fuel and air mixture. The fuel tank head space must be vented to enable fuel to be withdrawn from the tank during vehicle operation. In typical ORVR systems, a canister outlet is connected to the intake manifold of the vehicle engine through a normally closed purge valve. The canister is intermittently subjected to the intake manifold vacuum with the opening and closing of the purge valve between the canister and intake manifold. A computer which monitors various vehicle operating conditions controls the opening and closing of the purge valve to assure that the fuel mixture established by the fuel injection system is not overly enriched by the addition of fuel vapor from the canister to the mixture.

Fuel dispensing systems at service stations having vacuum assisted vapor recovery capability which are unable to detect ORVR systems waste energy, increase wear and tear, ingest excessive air into the underground storage tank and cause excessive pressure buildup in the piping and underground storage tank due to the expanded volume of hydrocarbon saturated air.

Refueling of vehicles equipped with ORVR can be deleterious for both the vapor recovery efficiency of a vapor recovery system and the durability of some system components. The refueling of an ORVR equipped vehicle deprives the vapor recovery system of gasoline vapors intended to be returned to the storage tank, typically located underground. In lieu of having gasoline vapor available, the vapor pump of an assist-type system pumps air back into the storage tank. The air pumped back into the storage tank vaporizes liquid fuel that is in the storage tank, pressurizes the storage tank and is then vented to the atmosphere as polluting emissions.

One known type of assist vapor recovery system attempts to avoid the storage

tank pressurization problem by sensing the presence of an ORVR equipped vehicle during refueling and uses this information to turn off the vapor pump during the refueling of an ORVR vehicle. A system's ability to recognize an ORVR equipped vehicle and adjust the fuel dispenser's vapor recovery system accordingly, eliminates the redundancy associated with operating two vapor recovery systems for one fueling operation. One example of this type of system is described in U.S. Patent No. 5,782,275 issued to Gilbarco and hereby incorporated by reference. The reduction in vapor or air flow rate during an ORVR refueling will be 100% when the vapor pump is turned off; however, some initial run time is required for the pressure sensor to activate and turn the pump off.

Another example of an assist vapor recovery system is described in U.S. Patent No. 6,095,204 issued to Healy and hereby incorporated by reference. The system of the '204 patent uses a vacuum control arrangement to limit air return in a vehicle equipped with ORVR so that the air return rate is only about 75% of the liquid gasoline delivery rate. This volume of air is disclosed as resulting in liquid gasoline evaporation underground sufficient to bring the total final volume back to a level equal to the liquid level dispensed.

Automobiles equipped with onboard refueling vapor recovery (ORVR) prevent gasoline vapor in the tank of automobiles from being transferred to the underground storage tank (UST) using the vapor recovery equipment of gasoline dispensers (nozzle, hose, vapor pump, etc.). With no gasoline vapor to transfer to the UST, the vapor recovery equipment intakes, and transfers air to the UST, which causes the pressure in the UST to increase because the ingested air vaporizes gasoline in the UST. As the pressure in the UST increases, the emissions from the vapor recovery system increase from leaks in the system (fugitive emissions). In order to make assist-type gasoline dispensers compatible with ORVR equipped vehicles, the amount of air transferred to

the UST when refueling an ORVR equipped vehicle must be reduced. However, operation of ORVR systems and vapor recovery equipment in gasoline dispensers together with seals between the nozzles and the filler necks which are provided to prevent the ingestion of air into the UST can lead to vacuum or pressure (relative to atmospheric pressure) in the filler neck. Such pressure or vacuum in the filler neck could adversely affect the operation of shut-off mechanisms in dispensing nozzles, causing either premature shut-off with a vacuum present, or no shut-off with pressure present.

Unfortunately, these and other known systems do not provide for assist-type vapor recovery systems that are compatible with ORVR systems while still maintaining the accurate and reliable operation of the automatic shut-off mechanism in the nozzle.

SUMMARY OF THE INVENTION

These and other problems with known fuel dispensing and associated vapor recovery systems have been overcome with this invention.

According to this invention, an improved nozzle and vapor recovery system configuration makes an assist-type gasoline dispenser compatible with ORVR equipped vehicles. Specifically, the spout shut-off mechanism of a nozzle functions without regard to variations in the level of vacuum in the filler neck, such as may occur when refueling vehicles having on board vapor recovery systems.

This invention utilizes an assist-type of nozzle that may be combined with a flexible boot to seal against the filler neck of the vehicle being refueled. This arrangement results in relatively high vacuum levels in the nozzle vapor space. To account for those vacuum levels, control of the shut-off mechanism is modified.

Current mechanical shut-off mechanisms for nozzles consist of a are diaphragm operated with a first side of the diaphragm vented to atmospheric pressure and a second, opposite side of the diaphragm vented to a vacuum producing poppet valve, which in turn is vented at the end of the nozzle spout. This invention vents both sides of the diaphragm near the end of the nozzle spout. Thus, in this invention two separate passageways lead from near the end of the nozzle spout, one leading to the vacuum producing poppet valve, then to the second side of the diaphragm, the other passageway leading to the first side of the diaphragm.

By venting both sides of the shut-off diaphragm in the same area in the filler neck, the shut-off diaphragm will not sense that there is any pressure or vacuum present on the filler neck (relative to atmospheric pressure) and the shut-off mechanism will operate in a normal manner. This invention allows the mechanical shut-off mechanism of the nozzle to be retained without modification and does not require, for example, conversion to an electronic shut-off. The respective openings of the spout vents may be positioned in several ways and only need to be in the same area of the filler pipe so that they are both subjected to any pressure variations that are present. In one embodiment of the nozzle according to this invention, the venting passageways are positioned inside the nozzle spout and in another embodiment of the nozzle according to this invention, the first side of the diaphragm is vented into the vapor path of the nozzle, for example into space between the spout and a surrounding boot, instead of a separate tube inside the spout.

As a further alternative embodiment, a vacuum assist vapor recovery dispenser is modified to render it ORVR compatible. Specifically, a bypass valve coupled to the vapor return line reduces the quantity of air ingested during refueling and minimizes the amount of air returned to the underground storage tanks (UST).

In this embodiment, a bypass valve is connected across the inlet and outlet of the vapor pump in the gasoline dispenser. The bypass valve, which is normally closed, is operated by a diaphragm, or other suitable means, connected to the inlet side of the vapor pump. Normally, the level of vacuum of the inlet to the pump is very low, i.e., the level merely corresponds to the pressure drop in the nozzle/hose/plumbing on the inlet side. With an ORVR vehicle, the vacuum level increases substantially due to the lack of vapor flow from a tank being refueled. This increased vacuum causes the bypass valve to open, simply allowing flow to recirculate at the vapor pump. This reduces the vapor/air flow back into the UST with an ORVR vehicle, reducing the pressurization of the UST.

As a complement, a vapor path primary valve can be placed on the inlet side of the vapor pump only. This primary valve is normally open. With an ORVR vehicle, the vacuum level increases substantially due to the lack of vapor flow. This increased vacuum causes the primary valve to close the inlet to the vapor pump. This reduces the vapor/air flow back to the UST with an ORVR vehicle, reducing the pressurization of the UST. The primary valve can also be modulated to control the vacuum at the nozzle.

Additionally, a secondary feature can be added to either the bypass valve or the primary valve configuration so that the vacuum level at the nozzle and filler neck can be regulated. A secondary valve is operated by the primary valve so that as the primary valve is operated to substantially closed the inlet side of the pump, the secondary valve is opened to regulate the vacuum level created by the ORVR system onboard the vehicle. In accordance with the present invention, the nozzle's shut-off characteristics are unaffected by the vacuum level in the filler neck, but the substantially elevated vacuum levels can cause the liquid in the filler neck to become elevated within the filler neck, and if the liquid reaches the tip of the nozzle, the nozzle's shut-off mechanism will function as it is intended to do. The complementary primary and/or secondary valves

can overcome the possibility of liquid reaching the tip of the nozzle.

During refueling of an ORVR equipped vehicle, vacuum levels will rise quickly to about 7 inches H_20 at which point the primary valve is set to actuate. With the primary valve actuated, the vacuum levels on the pump side increase substantially to the limits of the pump design. The vacuum levels on the nozzle side of the valve would similarly increase due to the action of the ORVR mechanism in the vehicle, but the secondary valve opens to reduce the vacuum level to prevent the liquid from shutting the nozzle off. It has been determined that a vacuum level in the filler neck of 3.0 - 5.0 inches H_20 can be tolerated during refueling.

The above-described approaches provide advantages in reduced cost and simple installation. Specifically, a reconfiguration of existing dispenser plumbing and the modification to the nozzle is all that is required. The nozzle still has to stay "on" long enough to operate the valve, and there is still a substantial amount of vacuum in the filler neck from the ORVR action of the vehicle. The primary and/or secondary valve is a desirable feature primarily because of the liquid in the filler neck as described above. The primary and/or secondary valve itself could be placed in the hose or in the dispenser. With regard to the bypass valve, it is a much cheaper piece of hardware than, for example a hydrocarbon sensor, is often faster to respond, and does not require any electrical connections or electrical control means. Finally, the bypass valve configuration can be retrofitted into existing dispenser vapor plumbing.

BRIEF DESCRIPTION OF THE DRAWINGS

The above-mentioned and other features and advantages of this invention, and the manner of attaining them, will become more apparent and the invention itself will be better understood by reference to the following description of embodiments of the

invention taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a fueling system for a vehicle operable according to this invention;

Fig. 2 is a cross-sectional view of a dispenser nozzle which will be referred to for explanation of one embodiment of this invention;

Figs. 3-5 are cross-sectional views of embodiments of an ORVR compatibility assembly which may be used in a vapor recovery system of the fueling system of Fig. 1;

Fig. 6 is a schematic illustration of an ORVR compatible dispenser nozzle configuration according to one embodiment of this invention;

Fig. 7 is a schematic illustration of an ORVR compatible dispenser nozzle configuration according to another embodiment of this invention; and

Fig. 8 is a schematic illustration of a vapor return bypass configuration for an ORVR compatible dispenser according to yet another embodiment of this invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to Fig. 1, a vehicle 10 is shown being refueled with a fueling system 12. A nozzle 14 is shown inserted into a filler pipe 16 of a fuel tank 18 of the vehicle 10 during the fueling operation.

A fuel delivery hose 20 is connected to the nozzle 14 on one end and to a fuel dispensing system 22 on the opposite end. The fueling system 12 includes a vapor

recovery system 24. As shown by the cut-away view of the interior of the fuel delivery hose 20, an annular fuel delivery passageway 26 is formed within the fuel delivery hose 20 for delivering fuel by a pump 28 from an underground storage tank (UST) 30 to the nozzle 14. A central, tubular vapor passage 32 as part of the vapor recovery system 24 is also within the fuel delivery hose 20 for transferring fuel vapors expelled from the vehicle's fuel tank 18 to the underground storage tank 30 during the fueling of the vehicle 10. The fuel delivery hose 20 is depicted as having the internal vapor passage 32 with the fuel delivery passage 26 concentrically surrounding it; however, other hose configurations are contemplated for use in the present invention.

As shown in Fig. 1, the underground storage tank (UST) 30 includes a vent pipe 34 and a pressure vent valve 36 for venting the underground tank 30 to the atmosphere. The valve 36 vents the tank 30 to air at about + 3.0 inches H_2O or -8.0 inches H_2O.

A vapor recovery pump 38 provides a vacuum in the vapor passage 32 for removing fuel vapor during a refueling operation. The vapor recovery pump 38 may be placed anywhere along the vapor recovery system 24 between the nozzle 14 and the underground fuel storage tank 30. Vapor recovery systems utilizing vapor recovery pumps of the type shown and described herein are well known in the industry and are commonly utilized for recovering vapor during refueling of conventional vehicles which are not equipped with on-board refueling vapor recovery (ORVR). A vehicle being refueled may include ORVR, for example an ORVR system 40 as shown in the vehicle 10 of Fig. 1.

The vehicle fuel tank of an ORVR equipped vehicle typically has an associated on-board vapor recovery system. The exemplary ORVR system 40 shown in Fig. 1 has a vapor recovery inlet 42 extending into the fuel tank 18. As the fuel tank 18 fills,

pressure within the tank 18 increases and forces vapors into the ORVR system 40 through the vapor recovery inlet 42. The ORVR system 40 also may use a check valve (not shown) along the filler pipe 16 to prevent further loss of vapors.

As liquid fuel rushes into the fuel tank 18 during the refueling operation, fuel vapors are drawn out of the fuel tank 18 through a spout 44 of the nozzle 14. The vapor recovery system 24 pulls the fuel vapors through the hose 20 along the vapor passage 32 and ultimately into the underground storage tank (UST) 30. This is standard operation when refueling vehicles not equipped with ORVR systems.

As shown in Figs. 6-8, the nozzle 14 may be configured to make an assist-type vapor recovery system 24 of the gasoline dispenser 22 compatible with ORVR equipped vehicles. Specifically, for these configurations, a fuel shut-off mechanism 100 of the nozzle 14 functions without regard to variations in the level of vacuum in the filler neck 16, such as may occur with ORVR systems 40.

Current mechanical shut-off mechanisms 100 for nozzles 14 include of a diaphragm 102, a first side 106 of the diaphragm 102 vents to pressure near the end of the spout 44 of the nozzle 14, a second side 104 of the diaphragm 102 is vented to a vacuum producing poppet valve 108, which in turn vents to the pressure near the end of the spout 44 of the nozzle 14. This invention vents both sides of the diaphragm 102 (Figs. 6-7) near end of the spout 44. Two separate passageways 112, 110 lead from the end of the spout 44, the second passageway 110 leading to the vacuum producing poppet valve 108, then to the second side 104 of the diaphragm 102, the first passageway 112 leading to the first, opposite side 106 of the diaphragm 102 (see Fig. 6).

To make the assist-type vapor recovery system 24 compatible with ORVR

equipped vehicles, the amount of air transferred to the UST 30 when fueling an ORVR equipped vehicle 10 must be reduced. By venting both sides 104, 106 of the diaphragm 102 in the same area in the filler neck 16, the shut-off diaphragm 102 will not sense that there is any pressure or vacuum present on the filler neck 16 (relative to atmospheric pressure) and the shut-off mechanism 100 will operate in a normal manner. The illustrated configurations enable the mechanical shut-off mechanism 100 of the nozzle 14 to be retained without modification and does not require, for example, conversion to an electronic shut-off. The respective vents or passageways 112, 110 may be positioned in several ways and only need to be in communication with the same area of the filler pipe 16 relative to any pressure variations that are present.

Referring to Fig. 2, a cross-sectional view of a nozzle 14 is shown. The nozzle 14 includes the spout 44 projecting forwardly from a nozzle body assembly 114. On the nozzle body assembly 114 opposite from the spout 44, the hose 20 is connected to the nozzle 14 as is shown in Fig. 1. The nozzle 14 includes a collection sleeve or boot 16 116 mounted to the forward end of the nozzle body 114 and surrounding the spout 44. The collection sleeve 116 includes a molded face seal 118 flared outwardly at a terminal end of the collection sleeve 116. The collection sleeve 116 has a series of corrugations 120 which provide flexibility to the collection sleeve 116 so that when the nozzle 14 and spout 44 are inserted into the filler pipe 16 of the vehicle 10 as shown in Fig. 1, the molded face seal 118 mates with the filler pipe 16 and surrounds a portion thereof on the vehicle 10 to provide seal substantially preventing the escape of air or vapor into or from the filler pipe 16 and collection sleeve 116 area.

The nozzle 14 also includes the shut-off mechanism 100, only portions or which are shown in Fig. 2. The shut-off mechanism 100 includes a venturi bushing body 122 and a venturi poppet member 124 having a head 126 and a stem 128 projecting from the head 126. The stem 128 is seated within the bushing body 122 and a spring 130 is

seated within the head 126 and concentrically around the stem 128 to bias the venturi poppet member 124 outwardly from the body 122. Additional aspects of the shut-off mechanism 100 and control of the shut-off mechanism 100 are shown schematically in Figs. 6 and 7. The shut-off mechanism 100 is standard in many nozzle designs known in the industry and advantageously requires no modification according to this invention for proper operation.

The nozzle body assembly 114 includes a standard trigger lever 132 which is pivotally coupled by a pin 134 to the lower end of a shut-off actuator stem assembly 136. The lever 132 includes a grip 138 for actuation by a user to dispense fuel through the nozzle 14 and into the vehicle 10. The nozzle body assembly 114 includes a lever guard 140 surrounding the lever 132 as is customary in many nozzle configurations. A lock 142 is provided to releasably retain the lever 132 in an "on" position as is well known.

The venturi poppet member 124, which is seated in an inlet 144 of a chamber 146 in the nozzle body 114, acts as the vacuum generator 108 which is in communication with the second side 104 of the diaphragm 102 and also with pressure near the end of the spout 44 via the second passageway 110 (see Figs. 6 and 7). The first side 106 of the diaphragm 102 of the shut-off mechanism 100 is also in communication with pressure near the end of the spout 44 via the first passageway 112. As fuel fills the tank 18 and the tank 18 becomes full, the fuel backs up into the spout 44 blocking the opening to the second passageway 110 so that vacuum created at the venturi poppet valve 124 is no longer bled off and a vacuum is applied to the second side 104 of the diaphragm 102 triggering the shut-off stem assembly 136 to turn off the flow of fuel through the nozzle 14. A stem 148 of the shut-off stem assembly 136 extends downwardly thereby releasing the lever 132 coupled thereto by the pin 134. This operation of the components of the shut-off mechanism 100 in the nozzle 14

is according to well known designs.

According to the embodiment of the invention shown in Fig. 6, two vent passageways 110, 112 are provided with both the vent passageways 110, 112 being inside the nozzle 44 and in communication with sides 104, 106, respectively, of the diaphragm 102. According to the embodiment of Fig. 7, the passageway 112, as identified by arrows A, is provided through the vapor path of the nozzle 114 instead of via a separate tube in the spout 44 as in Fig. 6 and the passageway 110 is vented through a side vent 154 in the spout 44.

As a result of the nozzle configurations shown in Figs. 6 and 7, by venting both sides 104, 106 of the shut-off diaphragm 102 to the end of the nozzle 44, the shut-off diaphragm 102 will not sense any pressure or vacuum differential present on the filler neck 16 and the shut-off mechanism 100 will operate as designed. Therefore, the vacuum generated by the ORVR system 40 on the vehicle 10 and the vacuum generated by the vapor pump 38 of the vapor recovery system 24 of the fueling system 12 will not prematurely actuate the shut-off mechanism 100.

As noted earlier with reference to Fig. 7, the nozzle configuration illustrated therein is similar to that illustrated in Fig. 6, with the exception that the first side 106 of the diaphragm 102 is vented into the vapor path of the nozzle 14 instead of via a separate vent tube in the spout 44.

To overcome a possible problem with a large vacuum near the end of the spout 44, i.e., drawing fuel into the spout 44 so that the shut-off mechanism 100 is prematurely actuated by the fuel rather than by any vacuum or pressure, a vacuum assist vapor recovery dispenser 22 may be modified as illustrated in Fig. 8. Specifically, a bypass valve 174 may be coupled to the vapor return line 32 to reduce

the quantity of air ingested during refueling and minimize the amount of air returned to the underground storage tank 30.

Referring to Fig. 8, the bypass valve 174 is connected across the inlet and outlet of the vapor pump 38 in the gasoline dispenser 22. The valve 174, which is normally closed, is operated by a diaphragm, or other suitable means, connected to the inlet side of the vapor pump 38. Normally, the level of vacuum at the inlet to the pump 38 is very low, i.e., the level merely corresponds to the pressure drop in the nozzle/hose/plumbing on the inlet side. With an ORVR vehicle 10, the vacuum level increases substantially due to the lack of vapor flow. This increased vacuum causes the bypass valve 174 to open, simply allowing flow to recirculate at the vapor pump 38. This reduces the vapor/air flow into the UST 30 when an ORVR vehicle 10 is being refueled, reducing the pressurization of the UST 30 and also the vacuum at the end of the nozzle 14.

As a further alternative for ORVR compatibility, a normally open valve may be placed on the inlet side of the vapor pump 38 only. With an ORVR equipped vehicle, the vacuum level increases substantially due to the lack of vapor flow from the tank of the vehicle. This increased vacuum causes the normally open valve to close the inlet to the vapor pump 38 thereby reducing the vapor/air flow back to the UST 30 when refueling an ORVR equipped vehicle 10, reducing the pressurization of the UST 30.

Additionally, a secondary feature can be added to either the bypass or the normally open valve configuration so that the vacuum level at the nozzle 14 and filler neck 16 can be regulated. A secondary valve is operated by the primary valve so that once the primary valve has substantially bypassed or closed the inlet side of the pump 38, the secondary valve is opened to regulate the vacuum level created by the ORVR system 40 onboard the vehicle 10. With the modifications made to the nozzle 14 as described herein, the nozzle's shut-off characteristics are unaffected by the vacuum

level in the filler neck 16, but the substantially elevated vacuum levels can cause the liquid in the filler neck 16 to become elevated within the filler neck 16, and if the liquid reaches the spout 44, the nozzle's shut-off mechanism 100 will function as it is intended to do.

During the refueling of an ORVR equipped vehicle, the vacuum levels will rise quickly to about 7 inches H_20 vacuum at which point the valve will be set to actuate. With the valve actuated, the vacuum levels on the pump 38 side will increase substantially to the limits of the pump 38 design. The vacuum levels on the nozzle 14 side of the valve would similarly increase due to the action of the ORVR mechanism 40 in the vehicle 10, but the secondary valve opens to reduce the vacuum level to prevent the liquid from activating the shut-off mechanism 146. With such an arrangement, a vacuum level in the filler neck 16 of around 3.0 - 5.0 inches H_20 can be tolerated during refueling.

The advantages of this invention relate to reduced cost and simple installation. Specifically, reconfiguration of existing dispenser plumbing and the modification to the nozzle are required. The nozzle 14 still has to stay "on" long enough to operate the valve, and there can still be a substantial amount of vacuum in the filler neck 16 from the ORVR 40 operation. The noted valve or valves could be placed in the hose 20 or in the dispenser 22. Further, when a bypass valve is used, it is a much cheaper piece of hardware than, for example a hydrocarbon sensor, is often faster to respond, and does not require any electrical connections or electrical control means. Finally, the bypass valve configuration can be easily retrofitted into existing dispenser vapor plumbing. .

As shown in Fig. 1, an ORVR compatibility mechanism 46 can be used as part of the dispenser system 12. An illustrative ORVR compatibility mechanism 46 is disclosed

in U.S. Patent Application Serial No. 10/684,051, filed October 10, 2003, now U.S. Patent No. 6,810,922, which is hereby incorporated by reference. Various embodiments/configurations of the compatibility mechanism 46 are shown in Figs. 3-5. As shown in Fig. 1, the ORVR compatibility assembly 46 is located on the hose 20 at the opposite end from the nozzle 14; however, the compatibility assembly 46 can alternately be placed between the hose 20 and the nozzle 14, incorporated directly into the nozzle 14, or anywhere in the fueling system 12 in fluid communication with the vapor recovery system 24.

Referring to Figs. 3 and 4, the compatibility assembly 46 includes a housing 48 with a primary vapor passage 50 there through and in communication with the vapor passage 32 in the hose 20. An upstream end 52 of the primary vapor passage 50 in the assembly 46 is connected through the hose 20 to the fuel nozzle 14 and, likewise, a downstream end 54 of the primary vapor passage 50 is in communication with the storage tank 30. For consistency herein, the end of the assembly 46 in communication with the fuel tank 18 and nozzle 14 is referred to as the upstream end 52 and the end of the assembly 46 in communication with the underground storage tank 30 is referred to as the downstream end 54.

A valve assembly 56 is mounted for reciprocal movement in the housing 48 and intersects the primary vapor passage 50 in the assembly 46. The valve assembly 56 includes a sliding valve member 58 having a generally cylindrical portion 60 and a valve passage 62 which allows for vapor flow through the primary vapor passage 50 when the valve assembly 56 is in a first position as shown in Fig. 3. The sliding valve member 58 reciprocates within a bore 64 in the housing 48 to a second position as shown in Fig. 4 in which the cylindrical portion 60 of the valve member 58 blocks or inhibits the vapor flow through the primary vapor passage 50.

An upper, proximal end 66 of the valve member 58 is connected to a diaphragm 68, bellows or other expansible member which is captured within a chamber 70 in the housing 48. A plate 72 is mounted between the upper end 66 of the valve member 58 and the diaphragm 68. A conical spring 74 is mounted between the plate 72 on the valve member 58 and an annular groove 76 in the housing 48. The spring 74 urges or biases the valve member 58 upwardly so that the valve assembly 56 is urged toward the first position as shown in Fig. 3. A secondary vapor passage 78 connects the chamber 70 to the primary vapor passage 50 upstream from the valve assembly 56 as shown in Figs. 3 and 4. In an alternate embodiment, the secondary vapor passage 78 is connected to the chamber 70 and the primary vapor passage 50 downstream from the valve assembly 56 as shown in Fig. 5.

A terminal end 80 of the valve member 58 includes a stop 82 juxtaposed to the housing 48 to define a secondary valve. An O-ring 84 is seated on a beveled surface 86 of the stop 82 for sealing an annular pocket 88 in the housing 48. A stem 90 projects from the valve member 58 through the pocket 88 and is connected to the stop 82. In the first position of the valve assembly 56 as shown in Fig. 3, the O-ring 84 and stop 82 are seated against the housing 48 to seal off an air bleed port 92 connected to an air bleed passage 94. The air bleed passage 94 is in communication with the primary vapor passage 50 upstream from the valve assembly 56. In the second position of the valve assembly 56 as shown in Fig. 4, the valve member 58 translates to extend the stop 82 from the sealing configuration with the housing 48 thereby opening the air bleed passage 94 for communication between the ambient atmosphere and the primary vapor passage 50.

In operation, the force of the spring 74 on the plate 72 and diaphragm 68 keeps the valve member 58 in the first position as shown in Fig. 3 when refueling non-ORVR vehicles so that the primary passage 50 in the assembly 46 is unobstructed and the air

bleed port 92 is closed. When refueling non-ORVR vehicles, the vapor recovery system 24 in the fueling system 12 retrieves fuel vapors from the vehicle fuel tank 18 and pumps them to the ullage in the underground storage tank 30. When refueling an ORVR 40 equipped vehicle 10, elevated vacuum levels in the vapor passage 32 of the hose 20 result from the vacuum pump 38 in the vapor recovery system 24 in combination with the ORVR system 40. The elevated vacuum levels are communicated through the primary and secondary vapor passages 50, 78 to the chamber 70. As a result of the elevated vacuum levels (or reduced pressure) in the chamber 70, the diaphragm 68 expands or moves within the chamber 70 as shown in Fig. 4. The movement of the diaphragm 68 likewise moves the valve member 58 toward the second position and overcomes the bias of the spring 74 while the reduced pressure or elevated vacuum condition exists in the chamber 70.

As a result of the movement of the diaphragm 68 and plate 72, compression of the spring 74 and translation of the valve member 58, the primary vapor passage 50 is blocked off because the valve passage 62 no longer provides for the flow of vapor in the primary vapor passage 50 through the assembly 46. Moreover, the vacuum of the vapor recovery system 24 is blocked from communicating with the ORVR system 40. The valve member 58 in the second position as shown in Fig. 4 blocks off the primary vapor passage 50 from the vacuum pump 38 of the vapor recovery system 24 and opens up the primary vapor passage 50 to the air bleed port 92. The size of the air bleed port 92 can be adjusted for compatibility with the containment pumping action of the ORVR filler neck to maintain the desired vacuum level in the passage 32 in vapor hose 20 to keep the valve member 58 in the second position.

As shown in Fig. 5, in an alternative embodiment the diaphragm chamber 70 is connected by the secondary vapor passage 78 downstream from the valve assembly 56. As such, when the elevated vacuum level or decreased pressure in the chamber 70

causes the valve member 58 to move to the second position, the vacuum level on the downstream end 54 or pump side of the valve member 58 will increase substantially and hold the valve member 58 in the second position until the pump 38 is stopped. In the embodiment of Fig. 5, the air bleed port 92 into the primary vapor passage 50 could be made as large as desired and even to the point of reducing the vacuum in the passage 32 of the vapor hose 20 below the valve assembly 56, including the nozzle vapor space to nearly zero. Nevertheless, in either embodiment of this invention reduction of vapor flow in the vapor passage 32 to the storage tank 30 would be at or near 100%.

The retrofit of an existing fuel system 12 to accomplish such an improvement is a simple matter of hanging a new nozzle assemble in the fuel system. It should be appreciated by those of ordinary skill in the art that the retrofit of existing fuel systems is easily accomplished with the implementation and installation of an assembly as described herein. Additionally, the installation of new fuel systems preferably includes an assembly according to this invention.

From the above disclosure of the general principles of the present invention and the preceding detailed description of at least one preferred embodiment, those skilled in the art will readily comprehend the various modifications to which this invention is susceptible. Therefore, I desire to be limited only by the scope of the following claims and equivalents thereof.

What is claimed is: